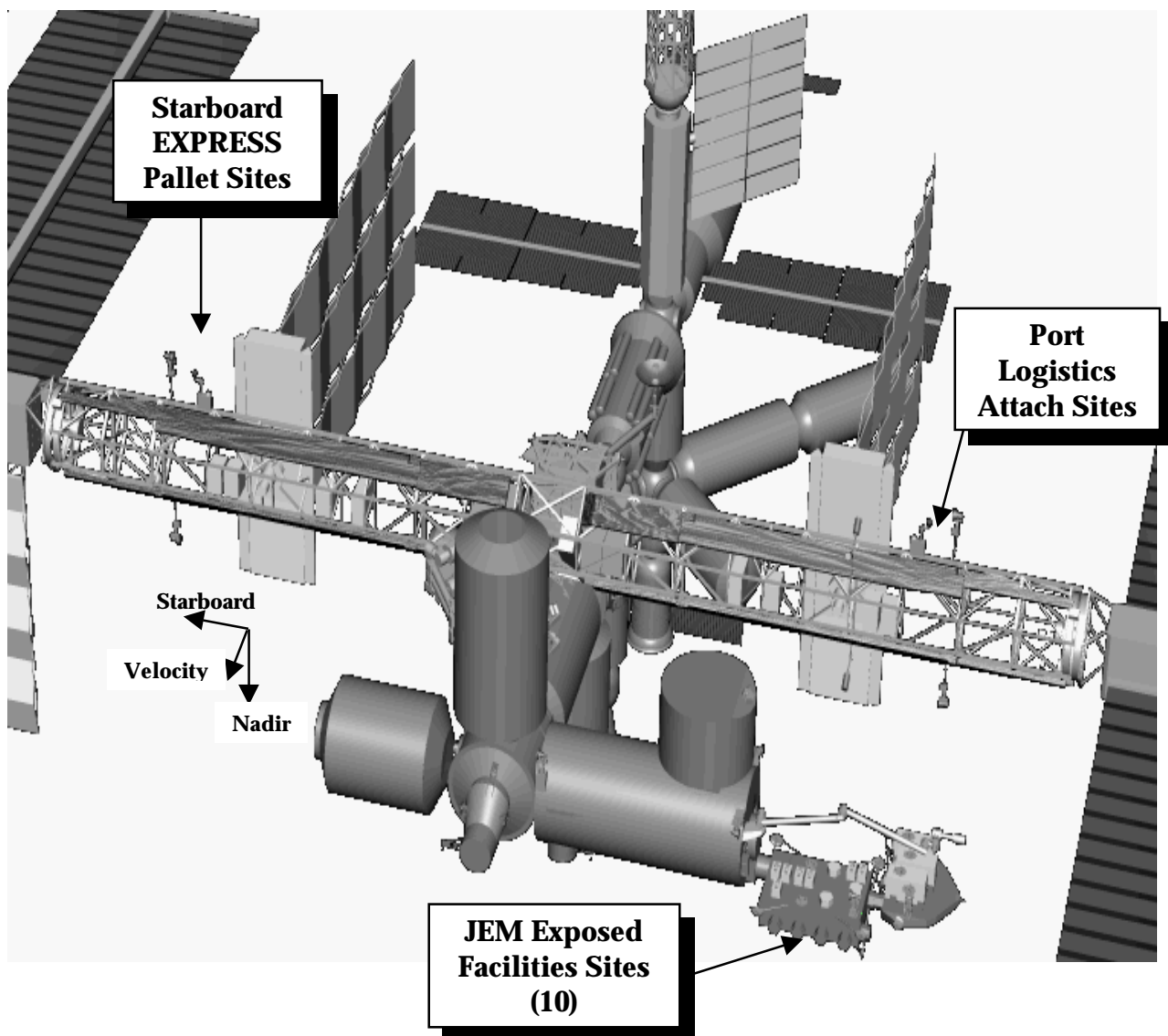


INTERNATIONAL SPACE STATION (ISS) UNESS RESEARCH OPPORTUNITIES

The International Space Station (ISS) will provide opportunities for attached payloads at several external locations. These locations consist of the U.S. Truss via the Expedite the Processing of Experiments to Space Station (EXPRESS) Pallet, the Japanese Experiment Module Exposed Facility (JEM-EF), and Columbus Exposed Facility (CEF). Each site offers unique capabilities and environments. Non-standard sites, which may not provide power or data through the ISS, may also be considered on a case-by-case basis. The ISS payload opportunity offered under this UnESS AO solicitation is for the EXPRESS Pallet only. Two nadir-pointing pallets are planned initially and the current OES allocations are on these pallets.

In addition to the attached payload opportunities, additional research opportunities are available in the internal, pressurized Window Observational Research Facility (WORF).



Section 1 – ISS Environment

The ISS is currently in the process of being assembled on-orbit. While assembly complete is anticipated for late in 2004, attached payloads will be flown as the attach sites become available. The U.S. Truss sites are scheduled to be manifested in 2003, followed by the JEM-EF in 2003, and the CEF in 2004. At this time, there is no opportunity for attached payloads to return on the Shuttle until after assembly complete. The minimum lifetime of the first payloads is therefore two years.

The WOLF is scheduled for launch in May of 2001. WOLF payloads may be launched on the same flight as the Facility. Based on available pressurized space on the Shuttles, payloads could launch and return on approximately three month cycles. Actual on-orbit duration and launch and return manifesting will be worked for individual payloads, based on payload requirements and Shuttle availability. It is generally assumed that WOLF payloads will not require power during launch or return.

Orbit

The ISS orbit will have an inclination of 51.6 degrees with an altitude that varies between 350 and 470 Km due to the solar cycle. The ISS orientation is continuously nadir pointed to earth. The orbit regression rate is one full orbit in two months. The ISS will pass regularly through the South Atlantic Anomaly.

Attitude

The ISS will use Global Positioning System (GPS) to determine the ISS state vector (position and velocity), attitude and altitude rates, and a time reference. GPS antennas will be located at the S0 truss segment. The system will provide a total position error of <3000 feet RSS and an attitude error of <0.46° per axis at the GPS antenna site. This position knowledge will degrade with distance to ~1 – 2 degrees at the S3 truss attach sites. The Station will estimate the on-orbit inertial rates at the GPS origin to within 0.01° per second per axis, at a 0.5 Hz bandwidth.

The vehicle stability will be 2.5 degrees/axis/orbit. Telescopes may need an active pointing system and star tracker to accurately point at chosen targets. Pointers will not be provided by the ISS program and are the sole responsibility of the Payload Developer. Pointers which have the potential of being modified for other payloads are being developed by ESA for specific EXPRESS Pallet adapter payloads.

ISS Induced Environment

The requirements for the overall ISS induced environment specify the following values for molecular column density and permanent molecular deposition:

Parameter Modeled	ISS Requirements: Quiescent	ISS Requirements: Non-quiescent
Molecular Column Density	1×10^{14} molecules/cm ²	Unlimited density is allowed, but frequency is limited
Permanent Molecular Deposition	1×10^{-14} g/cm s ² (-30 Å/yr)	1×10^{-6} g/cm s ² (-100 Å/yr)

The ISS Program and the appropriate Research Program Offices are developing molecular deposition requirements for individual payloads. Payloads that are extremely contamination sensitive should consider making their own deposition measurements in addition to providing protection for contamination sensitive surfaces. The contamination environment of the EXPRESS Pallet location will necessarily be determined by the Pallet analytical integration once all Pallet payloads have been selected.

There are three primary sources of induced contamination: deposition due to material outgassing, CO₂ dumps, and waste gas vents from pressurized payload racks or other attached payloads. Outgassing deposition at the attached payload sites is due primarily to neighboring attached payloads. Waste gas vents are short in duration and should be scheduled. CO₂ vents cannot be scheduled, but they do not exceed ISS induced environment requirements.

Safety

System safety from both a Space Shuttle and ISS standpoint will require significant consideration. The safety process is described in Section 4 of the Safety, Reliability, and Quality Assurance document located in the UnESSProgram Library.

Launch Vehicle

ISS EXPRESS Pallet payloads will be launched on the Space Shuttle. Carriers for the EXPRESS Pallet payloads will be provided by the ISS Program.

Section 2 - EXPRESS Pallet Description

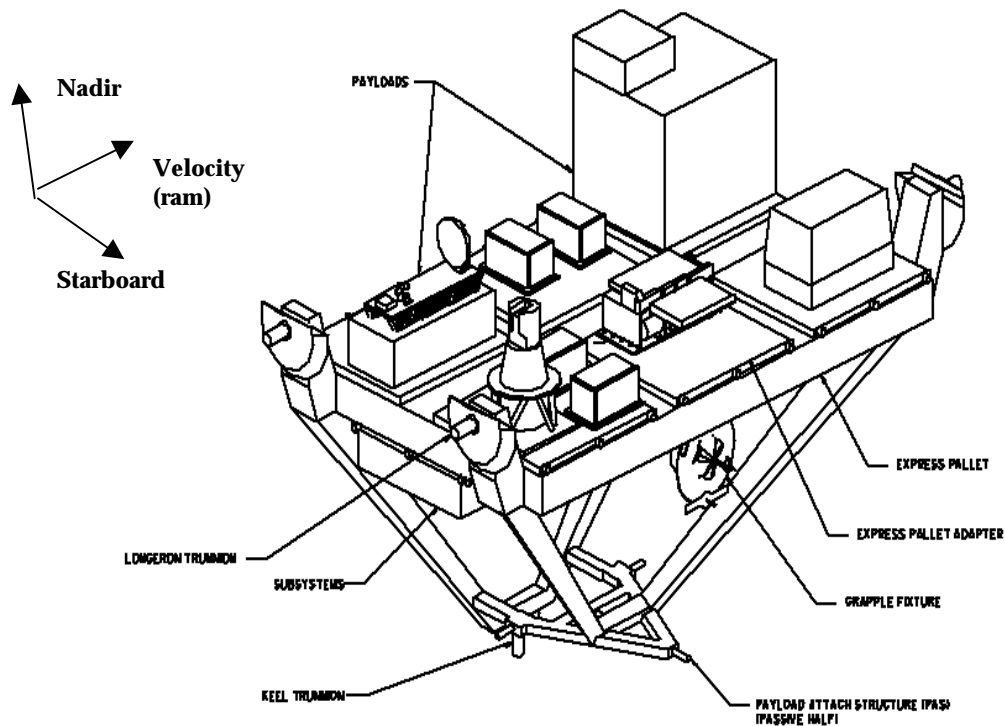
The EXPRESS Pallet provides the capability for six payloads to reside on a full truss attach site. Each payload sits on an adapter plate which attaches and detaches from the EXPRESS Pallet. The EXPRESS Pallet is managed by MSFC, and the hardware is being provided by Brazil.

Capability Per Payload

The payload mass limit is 227 Kg and must fit within an envelope of 1.1m (l) x 0.86m (w) x 1.2m (h). Up to 500W of power is available at 113 Vdc and 28 Vdc. Power usage will be limited by the thermal dissipation capability, which is site dependent. No thermal control is provided by the Pallet, and dissipation of heat into the pallet structure is limited to 50W. Data and command are available via a MIL-STD-1553 bus at ~1Mbps and ethernet access to the high rate data link at ~6Mbps.

The six payloads on a nadir Pallet sit on the nadir face of the Pallet. The Pallet itself sits on the wake side of the U.S. Truss with its longest dimension perpendicular to the Truss. All six payloads have a nadir field-of-view. The two payloads closest to the Truss will also have a ram (ISS velocity direction) field-of-view. The two payloads farthest from the truss have a wake field-of-view.

EXPRESS Pallet payloads will be provided with a Pallet adapter plate which also contains the necessary interfaces to the Station robotic arm. The first complement of Pallet payloads will be integrated with the EXPRESS Pallets at KSC and launched on the Pallets. Each entire Pallet will be robotically installed on a Starboard nadir attach site. At the end of their mission life, payloads will be retrieved individually by the Station robotic arm, placed on a carrier provided by the ISS Program, and returned via the Space Shuttle.



Express Pallet Configuration

Section 3 – Window Observational Research Facility

The Window Observational Research Facility (WORF) will be a 1-rack facility on ISS built to take advantage of the high optical quality nadir research window. This facility will allow deployment of payloads as large as a 23-cm (9") film aerial photography camera; the optical quality of the window will allow deployment of payloads with optical diameters of up to 30.4 cm (12"). The WORF is being built by the Boeing Corporation at Marshall Space Flight Center, and will be installed on Utilization Flight 2 (UF-2) in mid-2001.

The nadir window in the U.S. Laboratory is a 50.8-cm (20") clear aperture, fused silica window with a total of four panes. The outer most pane, called the debris pane, is 0.86 cm (0.37") thick and serves as a sacrifice pane to absorb micrometeorite and orbital debris (MMOD) impacts without damaging the pressure panes and threatening the ISS with decompression. This pane is designed to be removable on-orbit, so that any progressive deterioration in the optical quality of the pane can be accommodated with a new pane. The next two panes are the secondary and primary pressure panes. These panes are 3.175 cm (1.25") thick. The innermost pane, the scratch pane, is designed to protect the primary pressure pane from damage due to loose tools and other debris in the ISS, and will be removable. The combined set of pressure panes and debris pane will have an average optical performance of $1/10^{\text{th}}$ wave peak-to-valley over 6" (reference wavelength of 632.8 nm), which will give it the best optical performance of any window flown on a manned spacecraft¹. It is estimated that this window will be able to support, without window-induced optical degradation, a payload having a 30.4-cm (12") optical diameter. The window panes are given an anti-reflection coating which provides the best transmittance in the near UV, visible and near IR bands.

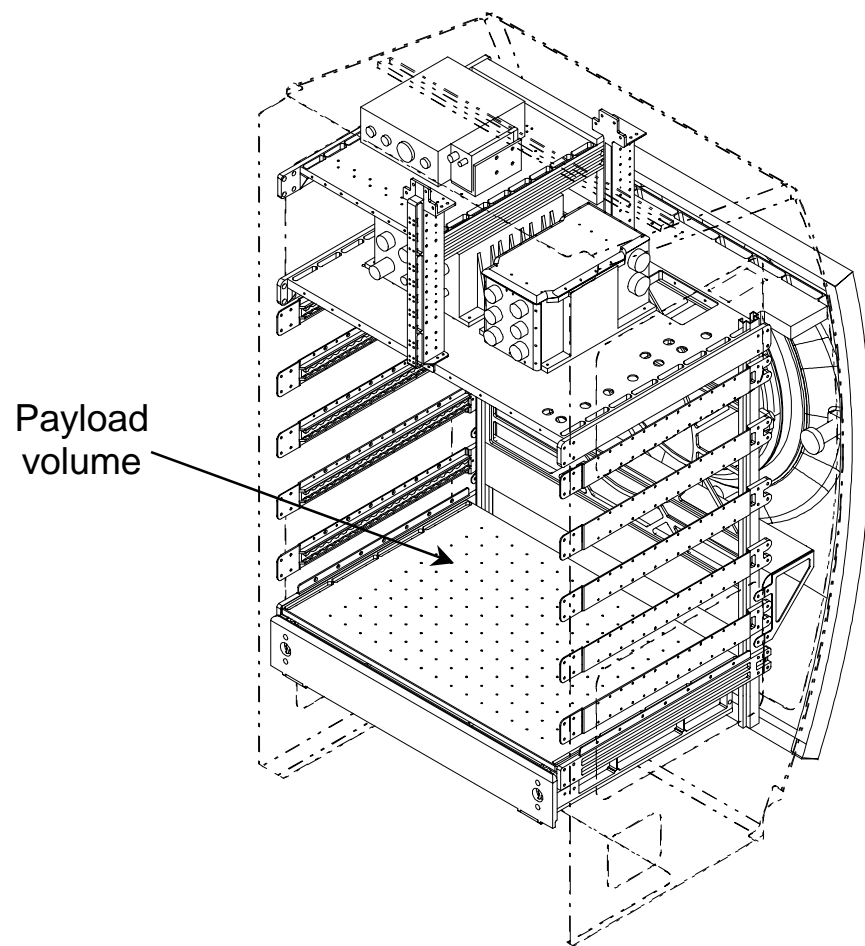
The WORF will be a single-rack facility based on a modified EXPRESS rack. This rack is designed to give payloads access to power, data, moderate temperature cooling, video downlink and a stable mounting area with standardized interfaces for payload deployment. The WORF is designed to handle a payload up to the size of a Leica-Heerburg RC-30 aerial photography camera, with maximum dimensions of 53.3 cm (21-in.) wide by 50.8 cm (20-in.) deep by 76.2 cm (30-in.) long and a maximum mass of 136 kg (299 pounds). Payload area is shown on a set of accompanying figures. It is anticipated that the WORF will supply interfaces for payload mounts on the sidewalls of the payload volume, and will provide a standard bolt interface on the lower surface of the payload volume for payload and avionics mounting. There will be interfaces within the payload volume to provide payloads access to ISS power, data and cooling utilities. The WORF will provide payloads with a maximum power of 3 Kw supplied at 28 Vdc. The maximum data rate will be up to 10 Mbps. The interior of the WORF will be designed to be light-tight and low-reflectance, so payloads will be able to observe low-light-level phenomenon such as aurora, and also be able to support radiometric measurements. At

¹ For comparison, the Space Shuttle Orbiter overhead windows have an optical performance of approximately 2 waves peak-to-valley over 4" (reference wavelength of 632.8 nm); the Skylab S-190B window had an optical performance of approximately $1/3^{\text{th}}$ wave peak-to-valley over 3" (reference wavelength of 632.8 nm)

present, design studies are underway to provide the WORF with passive rack-level vibration isolation so as to provide a stable environment for payload operations.

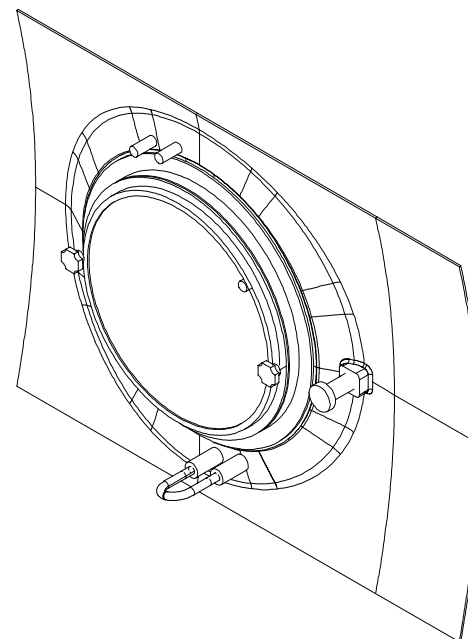
Payloads can be operated in any number of ways, ranging from complete crew interaction with payload operation to completely autonomous, ground-commanded operation with the only crew interaction being initial set-up. For payload set-up, the scratch pane will be removed and bump shield integral to the WORF will be deployed to prevent damage to the aft surface of the primary pressure pane by floating debris. Once payloads are mounted and under control, the bump shield will be retracted and the payload optics will be able to be moved into position directly adjacent to the pressure pane to take advantage of the optical quality of the window. It is anticipated that payload developers will provide all necessary mounting hardware, which will, in turn, mount to the interfaces provided in the payload volume.

Payload developers requiring addition information or clarification can contact either Dean Eppler at dean.b.eppler1@jsc.nasa.gov (281-244-8216) or Tony Boatright at tony.boatright1@jsc.nasa.gov (281-244-8087).

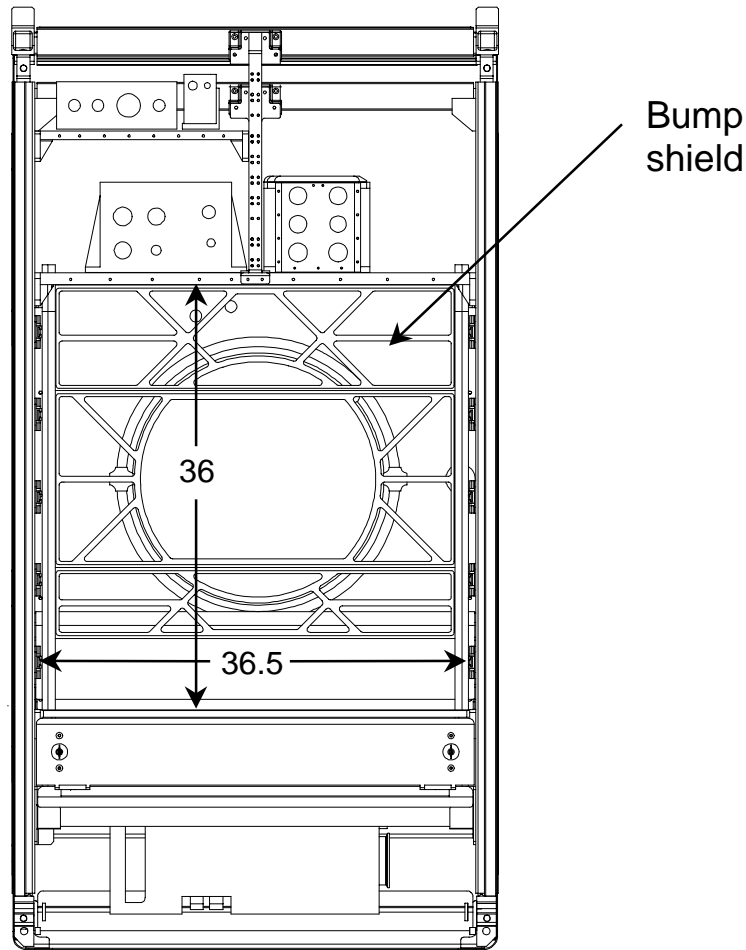


Payload
volume

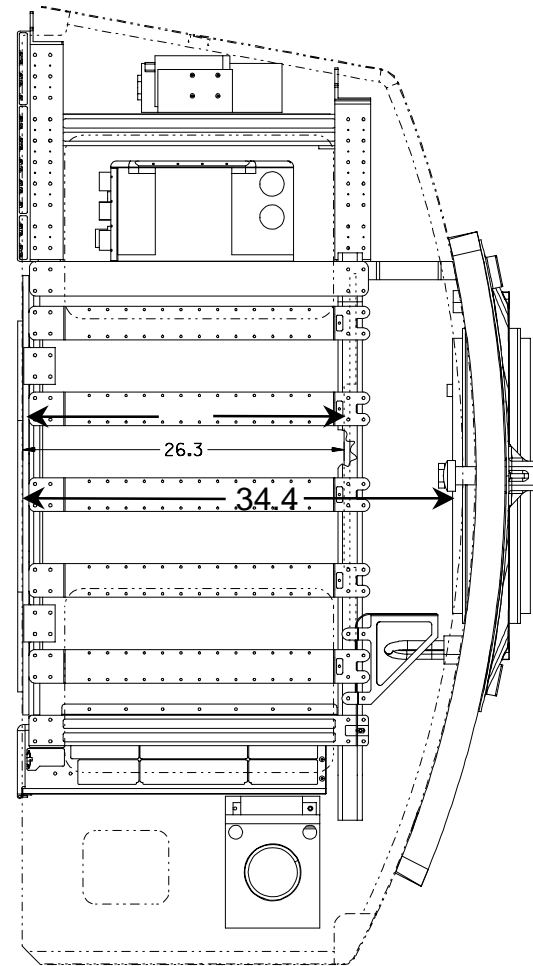
WORF 3/4 schematic view showing
the relationship between payload
volume



US Laboratory nadir window; the pane
has a 20" clear viewing area. To the right
of the window is the handwheel for opening
the window shutter. The "U"-shaped
structure
below the window is a quick disconnect (QD)
that controls the pressure between the two



WORF Rack face on, showing the dimensions of the payload area; dimensions in inches. The lattice work in front of the window is the deployed bump shield.



WORF Rack side view, showing depth of payload area. The total depth is 34.4". The 6.4" area to the right of the bump shield will be available once the bump shield is retracted, allowing payload use of the whole 34.4".

Section 4 – Payload Cost Assumptions

The proposer should not cost launch or landing services to the extent described below. The NASA ISS Payload Office and KSC budget process provides annual funding for KSC Launch and Landing Site payload processing. This processing is based on the Launch Manifest and approved support requirements as developed through the KSC Support requirements data set (SRDS) that is published as part the ISS payloads data set, SSP 52000-pds.

Table 4.1, Launch and Landing Site Services for NASA Sponsored Payloads, identifies existing KSC capabilities and services that are funded through the NASA budget process. This table will be included in Revision B of the SSP 52000-pds, now under review. It contains the most current information on provided services. If facilities, equipment, or service capabilities are requested that are greater than nominal levels of services available, then payload unique requirements, along with the Payload Developer (PD) unique requirement rationale, will be documented in Section 1.3 of the Payload Interface Agreement (PIA) Addendum. The KSC assigned Launch Site Services Manager (LSSM) will assist the PD when discussing what are the nominal levels of support. Any exceptional capabilities or services will not be provided at no cost to the PD unless approved and funded through the ISS Payloads Office. Payload Developers should cost exceptional capabilities and services in their proposal cost estimate.

Other services provided to payloads by the ISS Program include data transmission to ground with level 0 processing performed at MSFC. Data is then shipped to the user. Limited operations such as high level health and safety monitoring may also be performed at MSFC. Operating systems for command and telemetry from a payload operations center can be provided, although the operating platform must be provided by the payload developer.

EXPRESS Pallet adapter hardware will be provided to EXPRESS Pallet payloads. The integration of the payload to the Pallet is provided without charge, but must have personnel support by the payload developer. Payload mockups for astronaut crew training are not anticipated to be required unless the payload exceeds the standard volume for an EXPRESS Pallet payload. Interfaces to the EXPRESS Pallet are the joint responsibility of the payload developer and the EXPRESS Pallet project. Interfaces between the Pallet and the ISS and between the Pallet and the Shuttle, including the associated documentation, are the responsibility of the EXPRESS Pallet project.

TABLE 4.1 LAUNCH AND LANDING SITE SERVICES FOR NASA SPONSORED PAYLOADS

KSC Support Services			
Operations Support Services		Institutional Support Services	
1.	Pre-arrival planning/analysis support	1.	Emergency medical
2.	Ground Safety Review process	2.	Copy center and self service document reproduction
3.	Transportation support	3.	Self service document facsimile transmission
-	Arrival-Aircraft/Barge/Truck	4.	Federal Telephone System
-	Facility to facility	5.	KSC reference library*
-	Intra-facility	6.	Bus service between buildings*
4.	Facility Utilization	7.	Cafeteria (first shift only)*
-	Space Station Processing Facility (SSPF) Offline areas	8.	On-Center commercial travel office*
-	User Rooms	9.	KSC wide security access
-	Life Science Processing Facility	10.	On-Center security escort for equipment moves
-	SSPF Crane support	11.	Janitorial services*
5.	KSC Ground Support Equipment	12.	Mail service*
6.	Communications including Operational Intercommunication System (OIS)	13.	KSC area access badging
7.	Warehouse storage (limited)	14.	U.S. Customs planning/assistance support
8.	Packing/crating shipping support	15.	KSC Telephone Operator Support*
9.	Control work area access badging		
10.	Training for facility access and certifications		
11.	Clean room garments		
12.	Sampling and analysis (select)		
13.	Tools and special test equipment		
14.	Lifting equipment proof load		
15.	Equipment calibration		
16.	Technical shops		
17.	Office space		
18.	Photographic services		
19.	Hazardous waste disposal		
20.	Consumables (GN2, He, shop air, ISS flight water)		
21.	Computer Ethernet connections		
22.	Chemicals (select)		
23.	KSC Technical Document Center		
		* Monday thru Friday, 8:00am – 4:30pm	

* Monday thru Friday, 8:00am – 4:30pm

Section 5 – OES Research Program Office for ISS Utilization

The OES Research Program Office (RPO) for ISS utilization is the primary point of contact for all proposers interested in flying payloads on the ISS. Questions regarding ISS utilization, accommodations, and interfaces should be addressed to the Research Program Manager, Betsy Park, GSFC, Greenbelt, MD 20771, (301) 286-7062, fax 286-0232, bpark@pop400.gsfc.nasa.gov.

The RPO, in conjunction with the OES, is responsible for working ISS allocations, manifesting, ISS and STS interfaces for payloads, and issues regarding any of the above. Mission management of ISS payloads will be handled in the same manner as all UnESS missions.

Section 6 – References

More detailed information on ISS accommodations and requirements may be found in the ISS Utilization Guide at <http://spaceflight.nasa.gov/station/science>. This document will become available Septemb1999.

Additional References:

1. SSP 57000RC - PRESSURIZED PAYLOADS INTERFACE REQUIREMENTS DOCUMENT
(Available upon request)
2. SSP50404 -WINDOW OBSERVATIONAL RESEARCH FACILITY BLOCK I PROJECT REQUIREMENTS DOCUMENT
(Available upon request)
3. EXPRESS Pallet Interface Definition Document
(Available upon request.)